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Л.Ф. ГУЛЯНИЦЬКИЙ, В.Ю. КОРОЛЬОВ, М.І. ОГУРЦОВ,  
О.М. ХОДЗІНСЬКИЙ

**ПРОБЛЕМА МАРШРУТИЗАЦІЇ  
ГРУП БПЛА В ЗАДАЧАХ ПОШУКУ  
І МОНІТОРИНГУ**

[1 – 10].

[3 – 8]

( )  
[11 – 16].

**1.**

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. . . , 2018

[14].

[15, 16].  
 $(i = 1, \dots, n)$ ,  
 $t$   $\Delta t_i$

[16].

$$p_i = 1 - \exp\left(-\frac{\Delta t_i}{T_i}\right),$$

$T_i$   $i$ .

[16]:

$$\max P = \sum_{i=1}^n p_i \left( 1 - \exp\left(-\frac{\Delta t_i}{T_i}\right) \right).$$

$$\sum_{i=1}^n \Delta t_i = t, \quad \Delta t_i \geq 0.$$

[15].

[12 – 16].

[14, 15].

$$Z_E \quad v_p$$

$$v_m : Z_E = \frac{v_p}{v_m},$$

$$: v = \left(\frac{K}{T}\right) / \left(\frac{O}{S}\right),$$

$$, S -$$

$$v = L \cdot v, \quad L -$$

$$, v -$$

$$Z_E$$

[14, 15].

[12, 13].  $\Delta S$

$$: Z = \frac{\Delta S}{S} p, \quad \Delta S -$$

$$p$$

$$p : p = p \cdot p$$

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$$P = C_N^M W^M (1-W)^{N-M}, \quad W = \dots \quad [13]:$$

$$Z_N = \frac{1}{S} \cdot \sum_{k=1}^N \Delta S_k [1 - (1-p)^k],$$

$$\Delta S_k = \dots \quad [15]$$

$$B = \sum_{i=1}^r d_i + 2L,$$

$d_i = \dots, L = \dots, r = \dots$

[3-8].

2.

1.

(Stochastic VRP, SVRP).

[10].

3.

[1 - 9, 17].

$V_e$ ,

$V_a$  ( )

$V_b$  -

$G(V, E)$  - ,  $V = V_a \cup V_b \cup V_e$ , - ; -

( )  $C_{ij}$   $v_i, v_j \in V$ ;

$m$  - ;  $R_i$  - -  $(i = 1, \dots, m)$ ;  $R$  -

$R_i (i = 1, \dots, m)$ ;  $(R_i)$  -  $R_i (i = 1, \dots, m)$ ;  $K(v)$  -

$v \in V_e$ , ;  $q_i$  -

$i$  -  $(i = 1, \dots, m)$ .

(  $G$  )  $v_i$   $(x_i, y_i)$ .

$m$   $V_e$  -

$V_a$  -  $V_b$ .

:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} . \tag{1}$$



1.

$V_s$  (  $V_{es}$  ,  $K_i$  ).

4. ) .

3. «

» (VRP with Time Windows, VRPTW).

5. ; 1) ; 2) ( ; 3) ; 4) ; 5)

$V_b$  ; 1) ; 2) ; 3)

$V_a$

6) ; 4) ; 5) ;

( ,

),

,  $V_e$  -

, -

,  $V_a$ ,  $V_b$ , -

,  $V$ , -

,  $V_a$ , -

(  $V_e$  ). , ,

, -

, -

:

$$F_{VRP} = \sum_{i=1}^m C(R_i), \quad (3)$$

$C(R_i)$  -  $R_i, i = 1, \dots, m.$

(3).



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*L.F. Hulianytskyi, V.Yu. Korolyov, O.M. Khodzinsky, M.I. Ogurczov*

### PROBLEMS OF UAV ROUTING IN SEARCH AND MONITORING

The problems of search for mobile objects and territory monitoring with a group of unmanned aerial vehicles (UAVs) are considered. We show that a model of vehicles traffic with several depots can be applied to planning UAV group flight. The proposed problem statement allows us to accelerate the search of objects and minimize the required number of UAVs.

1. Golden B., Raghavan S., Wasil E. The Vehicle Routing Problem: Latest Advances and New Challenges, New York: Springer, 2008.
2. .... 2007. 1. . 122 – 132.
3. .., .., .. . 2017. . 199 – 201.
4. .., .. - . 2017. 1. . 82 – 89.
5. .., .. . 2016. 1. . 134 – 142.
6. .., .., .. ( . (12 – 15 2015 .. ). / - . 2015. . 247 – 248.
7. .., .. - . 2018. 1. . 11 – 19.
8. .., .., HLA. . 2017. 1(245). . 160 – 165.
9. . . : . ./ . - 2016. 133 . « »,

- 
10. . . . . ;
  11. ( . . . . . ) . . . . . , 2006. 368 .
  12. . . . . , 1970. 256 .
  13. . . . . , 1964. 390 .
  14. . . . . , 1956. 308 .
  15. . . . . , 1964. 208 .
  16. Jaiswal N.K. Military operations research: quantitative decision making, Springer Science, New York, 1997. 397 .
  17. . . . . . 2018. **17** . 107 – 114.
  18. . . . . . XXI . . . . . « . . . . . » (APAMCS-2015), 24 – 25 . 2015. : . 2015. . 320 – 322.
  19. . . . . . ( . . . . . ) : . . . . . 12 – 15 . 2015 . – / – [ . ]; . . . . . . 2015. . 113 – 114.

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**Про авторів:**

. . . . . ,  
. . . . . ,  
-mail: lh\_dar@hotmail.com

. . . . . ,  
. . . . . ,  
-mail: korolev@i.ua

. . . . . ,  
. . . . . ,  
-mail: romantic84@gmail.com

. . . . . ,  
. . . . . ,  
-mail: okhodz@gmail.ua